



ESAB Filler Metals for Double-Sided SAW Improve Mechanical Properties for 9% Ni LNG Tanks

- OK Autrod NiCrMo-4 wire and OK Flux 10.99 for submerged arc welding (SAW) provide higher notch toughness and better crack resistance.
- ESAB technical experts help customer develop new WPQR for consistently superior results.

Situation

Paresa S.p.A, Cesena, Italy, was founded in 1978. Today, this multi-discipline, single-source contractor is a leading fabricator and installer of storage facilities used by refineries, terminals, depots and power plants throughout Europe, Africa and South America. In 2018, the company invited ESAB to help improve SAW welding results for low-temperature cryogenic tanks made from 9% nickel steel.

Complication

The double-sided SAW process offers the highest level of productivity, but it is also susceptible to welding defects if set-up incorrectly. A wire/flux combination sourced from a competitor supplier did not provide the customer with the required margin of safety for meeting mechanical properties. Further, welding 9% Ni steel is sensitive to hot cracking. Paresa also wanted to address concerns related to filler metal moisture absorption.

Solution

ESAB LNG technical experts worked with Paresa to develop new Weld Procedure Qualification Records — now certified by world testing leader Bureau Veritas — for SAW welds using OK Autrod NiCrMo-4 wire and OK Flux 10.99 and tack welds with ESAB OK 92.55 Stick electrodes.

Results

In a head-to-head competition, the ESAB solution offered superior mechanical properties, giving Paresa a greater margin of safety for meeting strength and impact requirements. Because of its chemical composition, OK Autrod NiCrMo-4 is less sensitive to hot cracking. In addition, ESAB offers superior packaging for its filler metals, reducing the risk of moisture pick-up.



BENEFIT #1

Stronger SAW Welds

Cylindrical above-ground LNG storage tanks use a double-containment design featuring an outer tank made from pre-stressed concrete and an inner tank made from 9% Ni steel. Because the inner tank is directly exposed to the LNG at -162 °C, it must have high yield strength and notch toughness at low temperatures.

As Fig. 1 shows, the combination of OK Autrod NiCrMo-4 wire and OK Flux 10.99 exceeded Paresa's mechanical requirements and provided a greater margin of safety than competitive wire/flux combinations.

Fig. 1 OK Autrod NiCrMo-4 wire with OK Flux 10.99 (AC current)

	ESAB Solution (AWS As Welded)	Minimum Requirements
Tensile strength	720 MPa	680 MPa
Yield strength	480 MPa	430 MPa
Elongation	42%	35%
Charpy V-Notch	100 J (-196 °C testing temp)	56 J (-196 °C testing temp)
Lateral expansion	0.8 mm	0.38 (ductile fracture > 0.3 mm)

BENEFIT #2

Technical Expertise, New WPQR

The SAW WPQR developed by Paresa and ESAB features a double-V butt joint preparation. For the 26 mm wall thickness at the bottom ring, the outside of the joint requires seven welding passes and the inside requires eight. Travel speed must be synchronized between two SAW welding carriages so that the leading and trailing electrodes maintain a distance of about 70 mm. Torch angle, travel speed, welding parameters and wire diameter selection (2.4 mm in this case) all play critical roles.



Although it is a complex process, the skill and experience of Paresa's welding personnel enables them to execute the process in a highly productive manner. While Paresa needed to "walk" before running, the company now welds at a marathon pace, giving it production efficiencies and a competitive advantage.

BENEFIT #3

Improved Crack Resistance

ESAB has been providing products and services to the LNG tank industry for three decades and understands the complexity of using the double-sided SAW process for 9% Ni steel tanks. Previously, the industry standard had been to use a NiCrMo-3 wire. While it produces strong welds, the niobium and lower molybdenum content makes it more susceptible to hot cracking.

To address these concerns, ESAB developed OK Autrod NiCrMo-4, a wire that eliminates niobium while adding more molybdenum (Fig. 2), both of which make it less crack susceptible. Further, because impurities generate undue stresses as the weld pool solidifies, ESAB works directly with the steel mill to tightly control wire composition and consistency.

Of course, proper wire selection is only half the story with SAW. ESAB developed OK Flux 10.99 specifically to weld 9% Ni alloys with Ni-based wires using AC current (AC current eliminates magnetic arc blow, an effect to which 9%Ni steels are sensitive). OK Flux 10.99 provides stable arc, has very good weldability in the 2G welding position, and its high basicity provides good mechanical and better impact values.

Fig. 2 OK Autrod NiCrMo-4 Typical Wire Composition

Classifications Wire Electrode							
SFA/AWS A5.14:ERNiCrMo-4, EN ISO 18274:S Ni 6276 (NiCrMo16Fe6W4)							
Typical Wire Composition %							
C	Mn	Si	Ni	Cr	Mo	Fe	W
0.01	0.45	0.05	Bal.	15.5	16.1	5.8	3.5

BENEFIT #4

Superior Packaging

Because LNG tanks are erected in the field, Paresa requested moisture- and dirt-resistance packaging for ESAB filler metals so they could be transported and used on site without special storage considerations. To that end, ESAB developed a 25 kg steel drum for OK Flux 10.99 and ships OK Autrod NiCrMo-4 in 25 kg basket sealed in a plastic bag.



Paresa also uses ESAB OK 92.55 Stick/MMA electrodes (AWS ENiCrMo-6) for tack welding and some vertical up welds. OK 92.55 comes in VacPac, a laminated, multi-layer aluminum foil that is hermetically sealed around a strong plastic inner box, so users have no worries about porosity related to humidity.

ESAB also offers a full portfolio of filler metal and equipment for LNG applications. Contact your ESAB sales representative to learn more, or visit esab.com/lng.



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